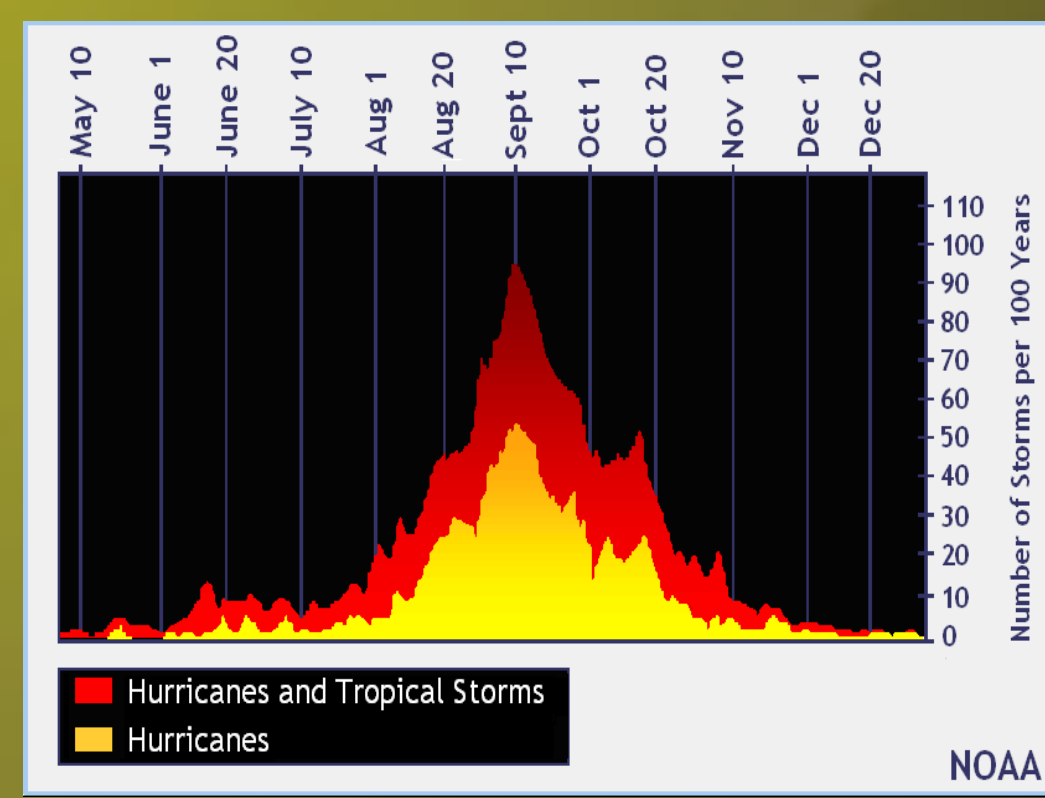


Prefabricated Intermodal Key-Service Efficient Sustainable Pre-positioned Expeditionary Assistance Kit

US Southern Command Hurricane Relief Aid

Design Scenario / System Constraints

- Pre-Positioned Expeditionary Assistance Kit (PEAK)
- Target: US Southern Command Beyond the Horizon Exercises
- Central America in September
 - Solar Insolation: 4.5kWh/m²-day
 - Average Daily Temp: 75°F
 - Record High/Low Temp: 108°F/50°F
- Shelter and Cooking for 30 people
- Set-up in less than one hour
- Purify Water from any source to NATO and WHO Standards
 - 117 gal/day for field staff, desire 600+ gal/day for humanitarian aid
- Power provided by Renewable Resources
- Energy Storage for PEAK Equipment and Communications



Hurricane Season for the Atlantic Basin

System Specifications

- Peak Power / Daily Energy Consumption: 3.5kW / 31kWh
- Environmental Impact Target: Neutral (less back-up power)
- HVAC Maximum Heating/Cooling Load: 15,000Btu/hr / 25,000Btu/hr
- System Weight (Maximum): 20,000lbs
- Cost Target: \$200,000

- 12 Monocrystalline PV panels mounted to the steel top of each MECC
- 12 Thin-Film PV sheets mounted to the cloth top of each MECC
 - Average Daily Horizontal Irradiation: 4.5 kWh/m²-day
 - Average Daily Temperature: 75°F (24°C)
 - System Conversion Efficiency: 86.6%
- Total Daily Energy Collected: 28.5kWh

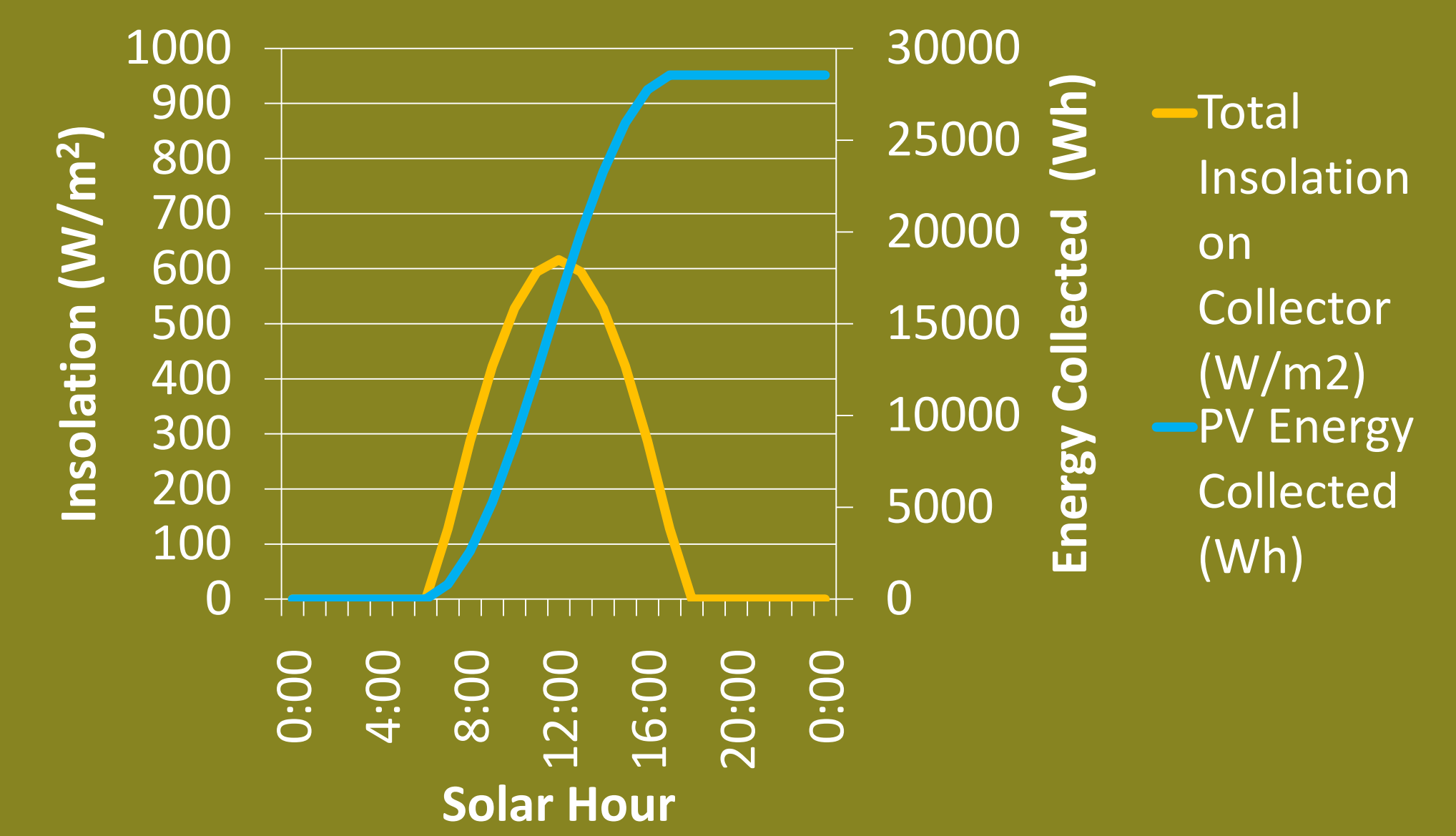


(2) MECC Expandable Container Shelters

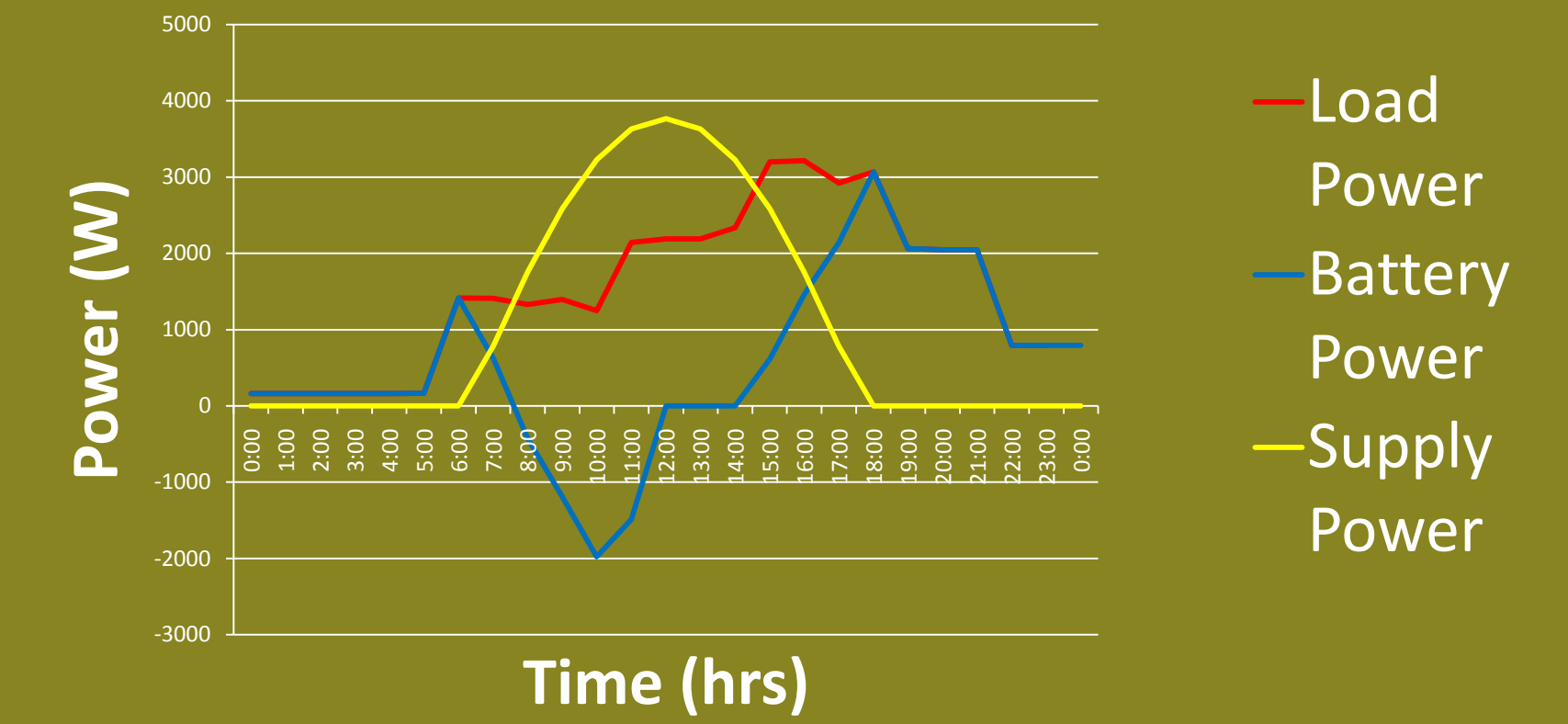
(12,900) Sanyo Eneloop NiMH Batteries



Solar Insolation on Collectors and Cumulative Energy Collected



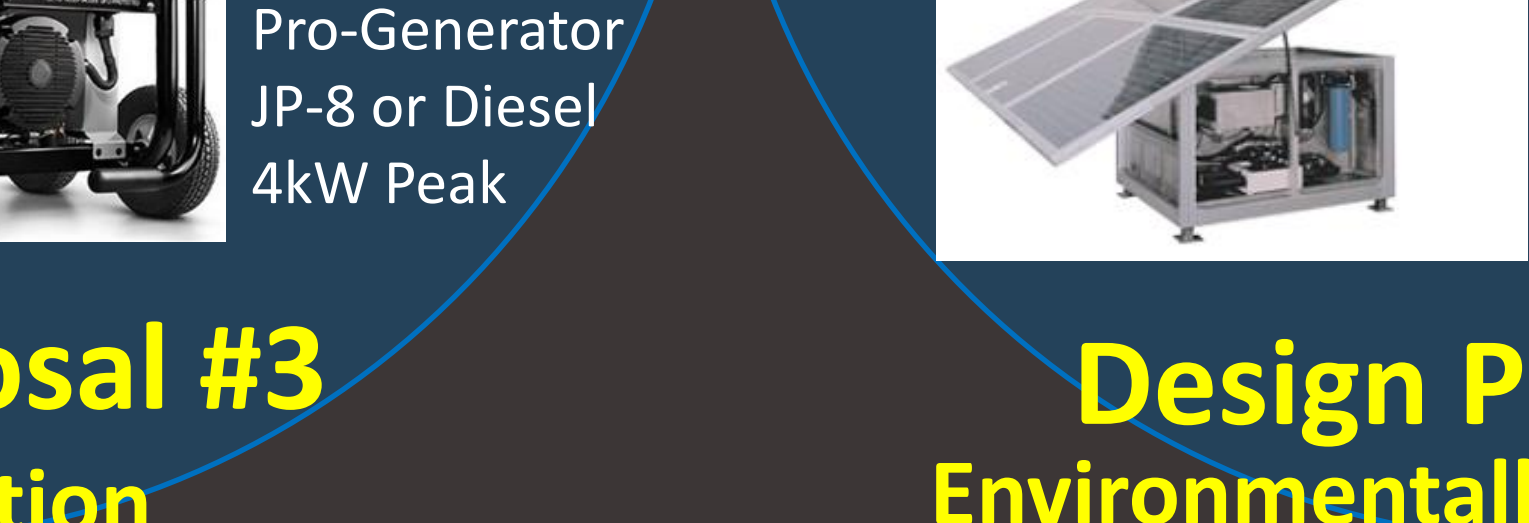
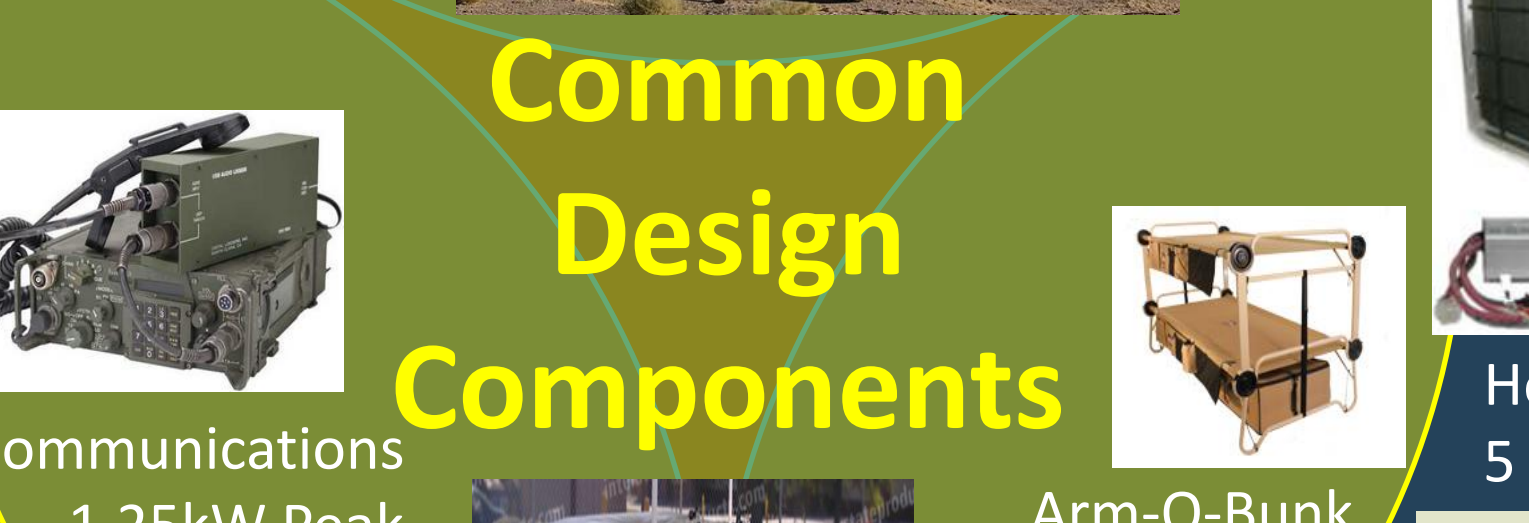
Daily Power Supply vs. Consumption



Design Proposals

Initially three significantly different designs were selected. Shelter, Power, Water Storage and Delivery Methods were held constant for all Design Proposals to minimize the complexity of the project. The components below were selected as best fit for all proposals.

Design Proposal #1 Low Power Consumption Option



Design Proposal #3 Low Cost Option

Design Proposal #2 Environmentally Friendly Option

"A Regional Combatant Commander's capability for promoting security and enhancing stability... during crisis events is constrained by a limited capacity for enabling critical services in support of distressed populations."

-Joint Capability Technology Demonstration (JCTD)

Design Selection

System Engineering Tools

PUGH ANALYSIS

Requirements	Weight	Proposal 1	Proposal 2	Proposal 3	Proposal 4
System	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score
Daily Energy Consumption	5	D	0	0	0
Effect on environment	5	A	0	0	0
Cost	1	T	0	-1	S
Weight	2	U	0	-2	S
Packaging	4	M	0	-4	S
Size of retail and pickup	5	D	0	-5	S
Availability of products	5	D	0	-5	S
Safety	5	D	0	-5	S
System Integration	4	D	0	-4	S
Total		0	0	-2	0

Requirements	Weight	Proposal 1	Proposal 2	Proposal 3	Proposal 4
System	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score
Daily Energy Consumption	5	D	0	+5	+5
Effect on environment	5	A	0	+5	+5
Cost	1	T	0	-1	S
Weight	2	U	0	-2	S
Packaging	4	M	0	-4	S
Size of retail and pickup	5	D	0	-5	S
Availability of products	5	D	0	-5	S
Safety	5	D	0	-5	S
System Integration	4	D	0	-4	S
Total		0	0	0	0

Pugh Analysis Scores
 Proposal #1: 0
 Proposal #2: -2
 Proposal #3: -9
 Proposal #4: 18

SYSTEM FMEA

Failure Mode	Failure Effect	Failure Cause	RPN	Actions	Target Date	Responsible
Can-Pure P3 2008B ROWPU Fuel: JP-8	Failure to provide clean water	Contaminated water source	48	Filter water before use	10/15/11	Andy Roberts
Mitsubishi AC Unit (x2) 1.3kW Peak	Failure to cool/heating	AC unit failure	48	Replace AC unit	10/15/11	Andy Roberts
Traeger Com 190 Pellet Cooker & Heater	Failure to cook/heating	Pellet cooker failure	48	Replace pellet cooker	10/15/11	Andy Roberts
B&S 4000 Pro-Generator JP-8 or Diesel 4kW Peak	Failure to provide power	Generator failure	48	Replace generator	10/15/11	Andy Roberts
Oshkosh HEMTT A4 Cargo Truck (x2)	Failure to transport	Truck failure	48	Replace truck	10/15/11	Andy Roberts
MECC (x2) Solar Panels	Failure to provide power	Solar panel failure	48	Replace solar panels	10/15/11	Andy Roberts
MiIMH Batteries	Failure to store power	Battery failure	48	Replace batteries	10/15/11	Andy Roberts
Mitsubishi Heat Pump (x2) 1kW Peak Load	Failure to provide heating/cooling	Heat pump failure	48	Replace heat pump	10/15/11	Andy Roberts
Communications 1.25kW Peak	Failure to provide communication	Communication failure	48	Replace communication equipment	10/15/11	Andy Roberts
Arm-O-Bunk (x15)	Failure to provide shelter	Bunk failure	48	Replace bunks	10/15/11	Andy Roberts
Interstate Products 600gal Pillow Tank	Failure to provide water storage	Water tank failure	48	Replace water tank	10/15/11	Andy Roberts
Mitsubishi Heat Pump (x2) 1kW Peak Load	Failure to provide heating/cooling	Heat pump failure	48	Replace heat pump	10/15/11	Andy Roberts
Tuli-Hybrid Solar Cooker (x5)	Failure to provide cooking	Solar cooker failure	48	Replace solar cooker	10/15/11	Andy Roberts
Spectra SSW 5800 ROWPU Consumption: 2.5kWh/day Production: 4.3kWh/day	Failure to provide power	Generator failure	48	Replace generator	10/15/11	Andy Roberts

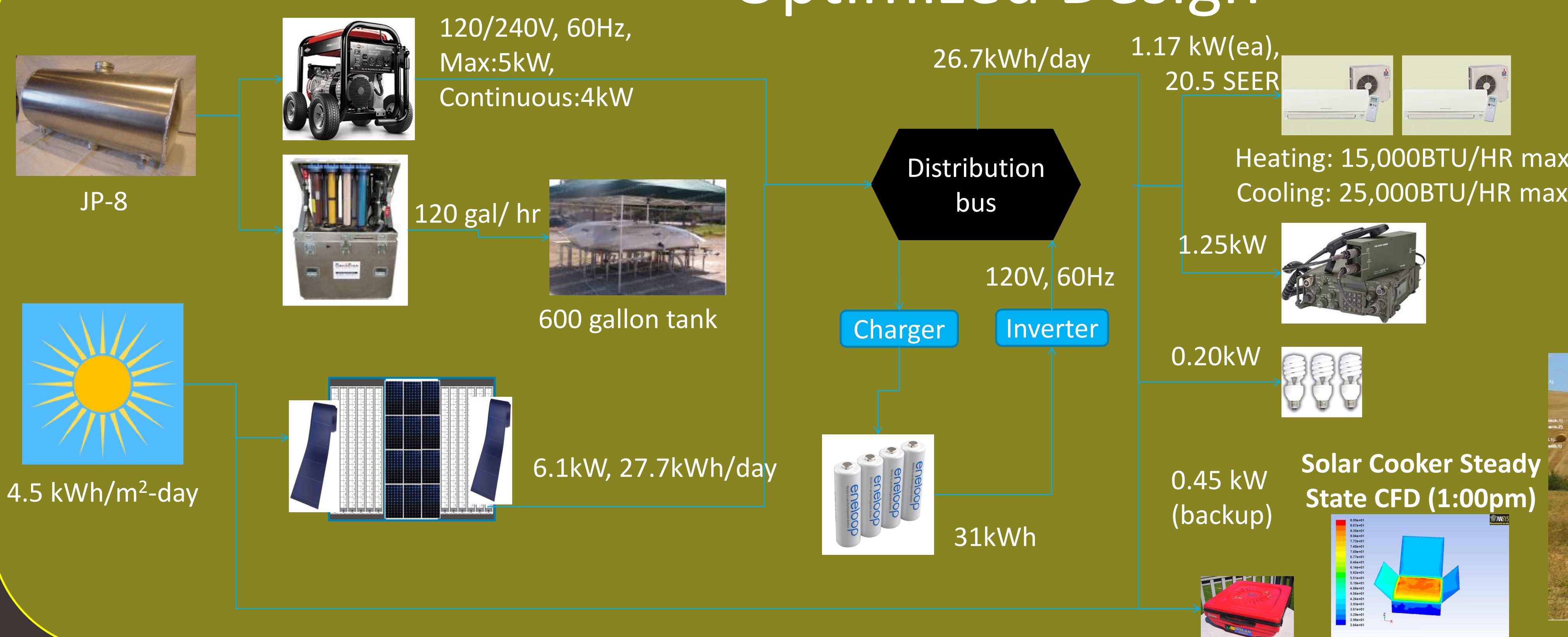
Initial Pugh Analysis Identified Design Proposal #1 as the Best of the Three Initial Options

FMEA on Proposal #1 Identified High Risk Items. Actions Taken on High RPN's led to Design Changes and the New Final Design Proposal (#4)

Design Selection Highlights

- Design Proposal #1 had flaws that were identified using the Pugh Analysis and System FMEA
- Several flaws were related to the pellet cooker → Replaced by the solar cooker from Proposal #2
- Elimination of Pellet Cooker required new HVAC → HVAC replaced by Heat Pump in Proposals #2&3

Optimized Design



Optimized Design Summary	
Peak Power	4.24kW
Consumption	26.7kWh/day
Net Energy Consumption	(1.0kWh /day)
Weight	12,930lbs
Cost	\$302,827

MECC Transient CFD